



АГЕНТСТВО МЕЖДУНАРОДНЫХ ИССЛЕДОВАНИЙ

ИННОВАЦИОННЫЕ ПОДХОДЫ К РЕШЕНИЮ СОВРЕМЕННЫХ ПРОБЛЕМ: КОМПЛЕКСНЫЙ АНАЛИЗ И ПРАКТИЧЕСКАЯ РЕАЛИЗАЦИЯ

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RESEARCH ON APPLYING SOME BIOLOGICAL METHODS TO TREAT WASTEWATER POLLUTION

Annotation

In the context of socio - economic development, the urbanization process is taking place rapidly in many countries, especially in developing countries including Vietnam. Urbanization helps expand infrastructure and industrial development, contributing to promoting economic growth, improving people's lives and modernizing society. However, along with that is the discharge of untreated wastewater or wastewater not treated according to standards by industrial parks and residential areas. This causes many impacts on the receiving source and the surrounding environment. Therefore, wastewater treatment technologies have been widely applied to improve the quality and protect the water environment such as chemical, physical, biological technology or applying a combination of the above methods. In this article, the research team chooses the biological treatment method as an environmentally friendly technology to apply to treat some indicators in the wastewater of Van Phuc silk village, Nhue river water and domestic wastewater of Ecohome 1 residents – Hanoi, Vietnam.

Keywords

Wastewater, pollution, biological methods, plant, microorganism

1. Introduction

According to the World Health Organization (WHO), about 80 % of waterborne diseases and nearly 90 % of infectious diseases in developing countries are related to water pollution [1]. The main sources of wastewater pollution come from domestic, industrial, agricultural, and urbanization activities. Wastewater contains many toxic compounds, organic substances, bacteria, and excess nutrients such as nitrates and phosphates, which can lead to eutrophication, creating conditions for excessive algae growth and causing phenomena such as "pink sea" or "aquatic wilt" (UNEP, 2018).

In Vietnam, surface water is an essential resource for daily life, agricultural and industrial production and the conservation of natural ecosystems. However, in recent years, surface water pollution has become increasingly serious, especially in rapidly urbanizing areas, industrial zones and traditional craft villages. Major rivers such as To Lich River (Hanoi), Nhue River (Hanoi), Ngu Huyen Khe River (Bac Ninh)... are suffering from a large amount of untreated wastewater from daily life, industry and agriculture. Many river branches have exceeded the allowable standards for pollution indicators such as BOD, COD, Amoni, Coliform... directly affecting public health and aquatic ecosystems. Worryingly, many surface water sources that were once used for domestic water supply, irrigation or aquaculture are no longer up to standards for use. About 20,000 people have been found to have cancer, the main cause of which is water pollution. About 44 % of children are infected with worms due to using water of poor quality. 27 % of children under 5 years old are malnourished due to lack of clean water and poor sanitation

(according to WHO). About 21 % of the population is using water contaminated with Arsenic - or inorganic Arsenic, an extremely toxic chemical commonly used in the production of herbicides and pesticides.

To solve this problem, the research team has chosen to propose the topic: "Research on wastewater pollution treatment by biological measures". This is one of the effective, cost - saving and environmentally friendly methods to treat wastewater pollution using biological measures. This method utilizes microorganisms, plants or natural ecosystems to decompose or absorb pollutants. According to research by [4], biological wastewater treatment systems not only help remove organic pollutants but also have the ability to treat nutrients such as nitrate and phosphate, contributing to improving wastewater quality effectively and sustainably. Specifically, biological treatment techniques such as biofilter systems, aerobic biological tanks, or the use of aquatic plants in flooded areas are feasible, low - cost and easy - to - maintain solutions [5]. In addition, advanced biotechnology such as the use of microorganisms is also opening up new prospects in the treatment of difficult - to - degrade pollutants, helping to increase treatment efficiency and reduce costs.

2. Research methods

2.1. Method of collecting documents

Collect, synthesize, inherit research results, publish domestically and internationally in prestigious journals related to the research field including:

- Documents on domestic wastewater, industrial / craft village wastewater.
- Wastewater treatment technologies.
- Method of treating wastewater pollution by microorganisms.

2.2. Field survey methods, sampling and sample processing

Survey the current status of the basin where there is waste discharge due to domestic and production activities, collect samples at the discharge points. The collected samples will be stored in cleaned plastic bottles with a volume of 500ml. Store in cold storage (4°C) after being brought to the laboratory.

2.2.1 Method of water sample analysis

The analysis process of collected surface water samples follows the instructions in the set of national technical standards of Vietnam.

pH and TSS indicators are quickly measured with a meter.

BOD₅, Total N, Total P, Coliform indicators analyzed in the laboratory.



Figure 1. Measuring water parameters in the laboratory



Figure 2. Experimental design for Coliform measurement

2.2.4. SWOT method

SWOT analysis is a method to help evaluate the overall issue of concern by identifying the factors of strengths, weaknesses, opportunities and challenges. From there, choose the optimal solution.

2.2.5 Statistical data processing methods

Use GraphPad and Excel statistical data processing software to process sample analysis data and experimental results.

2.2.6 Method for evaluating the effectiveness of color pollution treatment

Select strains capable of producing laccase and treating crystal violet and methylene blue to test the ability to decolorize and treat pollutants in water by shaking culture method at 30°C.

Add 100 μ l of spore solution to a shaker containing 10ml of water. After 7 days, re-measure the parameters to evaluate the treatment effectiveness.

3. Research results

3.1. Water quality analysis results

3.1.1. Water quality in silk village area

Conduct water quality analysis samples collection and analysis at 6 locations including: 1 location at ECOHOME 1 apartment area, 1 location at Pho Vien bridge, 2 locations near Am bridge area and 2 locations on Pho Lua.



Figure 0 Water sampling location

The results of water quality analysis are as follows:

Table 1 Results of water quality analysis at initial sampling time

Model name	Analysis indicators					
	pH	TSS (mg / l)	BOD ₅ (mg / l)	Total P	Total N	Coliforms (MPN / 100ml)
Am Bridge 1	7.8	120	76	4	1.2	1,100
Am Bridge 2	7.1	100	50	3	1	460
Silk Street 1	8	180	70	5.3	1.4	21,000
Silk Street 2	7.9	220	76	4.3	1.1	46,000

From the above analysis results, it can be seen that wastewater at sampling locations has high concentrations of TSS, BOD₅, and Coliform. Most of the water quality indicators are classified as average, poor, or very poor.

3.1.2. Water quality taken from Nhue River

The Nhue River is a small branch of the Red River, starting from Lien Mac sluice (Bac Tu Liem, Hanoi), ending at Phu Ly, Ha Nam province, with a total length of 113.6km. However, over the years, this river has been polluted, which has significantly affected agricultural production and the health of people in the localities in the basin.

Table 2 - Table of wastewater analysis results in the Nhue River area

Parameter	Unit	Method analysis	NT2 (Nhue River)	QCVN 40:2011 / BTNMT, Column B
TDS	mg / l	ENVI HD QHTN 09	1,242	-
Total N	mg / l	TCVN 6638:2000	72.2	40
Total P	mg / l	TCVN 6202:2008	1.53	6

The results showed that at the sampling location of Nhue River, there were signs of nutrient pollution, heavy nitrogen pollution, and pollution pressure from domestic and production wastewater still clearly existed. Although the Phosphorus content did not exceed the standard threshold, it needed to be controlled to avoid eutrophication.

3.1.3. Domestic wastewater quality in Ecohome 1 area

Ecohome 1 apartment complex is located in Dong Ngac ward, Bac Tu Liem district, Hanoi - an area with increasing population density along with the rapid development of new urban areas. However, besides the benefits of infrastructure and green living

environment that the project aims for, residents here are still facing the problem of surface water pollution from canals and drainage ditches around the area. The main cause comes from untreated domestic waste discharge from surrounding households, wastewater from spontaneous residential areas and some small - scale production facilities. The drainage ditches are often stagnant, smelly and discolored, especially in the summer or when there is little rain, affecting air quality and the daily lives of people.

Table 3 - Wastewater analysis results table at Ecohome 1 area

Parameter	Unit	Method analysis	Analysis results	QCVN 40:2011 / BTNMT, Column B
TDS	mg / l	ENVI HD QHTN 09	1,674	-
Total N	mg / l	TCVN 6638:2000	109.8	40
Total P	mg / l	TCVN 6202:2008	5.52	6

In addition, domestic wastewater at ECOHOME 1 apartment complex has a foul odor, cloudy water, and Nhue River water samples have a foul odor and are cloudy. The textile industry uses many types of synthetic dyes and discharges a large amount of highly colored wastewater due to the poor absorption capacity of these dyes in fabrics. This highly colored textile wastewater seriously affects the photosynthetic function in plants. It affects aquatic organisms due to its low light penetration and oxygen consumption. Most dyes are toxic, carcinogenic or mutagenic and can be hazardous to health; affect the eyes and skin, damage internal organs such as the liver and kidneys; and disrupt the photosynthesis process in water bodies. Therefore, textile wastewater needs to be treated before being discharged into the environment.

3.2. Evaluation of wastewater treatment efficiency by biological technology

3.2.1. Evaluation of phytoremediation effectiveness

The research team used Vetiver grass and Water Hyacinth to evaluate the wastewater treatment capacity of the Nhue River area and domestic wastewater of ecohome 1 area.



Figure 4. Wastewater treatment plant model of the research team

The research team recorded the results for 4 weeks, including 2 repetitions to get accurate results, then took the water sample for analysis in the laboratory.

After 2 weeks of observation, the roots of Vetiver grass and water hyacinth grew and the water parameters decreased, the water color was clearer than the original sample.

After 3 weeks, the research team continued to collect water samples for analysis in the laboratory to synthesize P and N results.

Table 2 Results of water quality analysis after treatment

Parameter	Unit	Analysis results					
		NT1	NT2	NT3	NT4	NT5	NT6
Total N	mg / l	22.4	38.1	8.95	17.1	28.9	39.8
Total P	mg / l	0.86	2.49	4.01	0.86	1.04	1.79

Laboratory analysis results showed that after phytoremediation, water quality in the sampled areas decreased compared to the original.

3.2.2. The ability to treat wastewater pollution in silk villages using fungal strains

a. Effectiveness of using *Curvularia lunata* strain

Using *C. lunata* strain to treat pollution. After 7 days of treatment, the water sample quality is as follows:

Table 5 - Results of water quality analysis after treatment by *C. lunata*

Model name	Analysis indicators					
	pH	TSS (mg / l)	BOD ₅ (mg / l)	Total P (mg / l)	Total N (mg / l)	Coliforms (MPN / 100ml)
Am Bridge 1	7.6	110	66	3.5	1	160
Am Bridge 2	7.0	80	45	2.8	0.9	240
Silk Street 1	7.3	140	60	4.2	1	1100
Silk Street 2	7.2	120	62	3.3	0.9	2400

Through the chart, it can be seen that the samples after being treated with the fungal strain had better quality, the parameter content values decreased significantly, especially the Coliforms index decreased significantly.

b. Effectiveness of using *T. harzianum*

Using *T. harzianum* to treat pollution. After 7 days of treatment, the water sample quality is as follows:

Table 6 - Results of water quality analysis after treatment by *T. harzianum*

Model name	Analysis indicators					
	pH	TSS (mg / l)	BOD ₅ (mg / l)	Total P (mg / l)	Total N (mg / l)	Coliforms (MPN / 100ml)
Am Bridge 1	7.2	103	57	3.2	0.9	240
Am Bridge 2	6.8	83	40	2.2	0.9	290
Silk Street 1	7.1	145	62	4.5	1	4600

Model name	Analysis indicators					
	pH	TSS (mg / l)	BOD ₅ (mg / l)	Total P (mg / l)	Total N (mg / l)	Coliforms (MPN / 100ml)
Silk Street 2	7.2	110	58	4.2	0.8	11000

The samples after being treated with the fungal strain had better quality, especially the Coliform index decreased significantly.

4. Conclusion

Through the research process, the research team drew the following conclusions:

- Wastewater from the river section in the areas: Ecohome 1, Nhue River, Van Phuc Silk Village is polluted. Through analysis of 6 samples in the area of Ecohome1, Nhue River, Cau Am and Pho Lua, it was found that some indicators such as TSS, BOD₅, Coliform showed average, bad or very bad water quality.
- After selecting the *Curvularia lunata* strain for shaking culture for 7 days, the water quality was found to have improved. In particular, the Coliform and color pollution indicators were significantly reduced.
- The treatment method using Vetiver grass and water hyacinth is effective in treating N and P. This is also an effective and environmentally friendly treatment method.

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